

REMARKS

The application is believed to be in condition for allowance for the reasons set forth below.

Claims 26-38 and 44-47 are pending in the application. Claims 26-33, 38, 44 and 47 are withdrawn from consideration as being drawn to a non-elected species.

Formal matters

With respect to the rejection under 35 U.S.C. 112, first paragraph of claims 34-37, 45, 46:

Examples 13-17 and 23 of Table 5 show a flame retardant epoxy resin composition comprising an epoxy resin (A), a phenolic resin (B), an inorganic filler (C) and a curing accelerator (D).

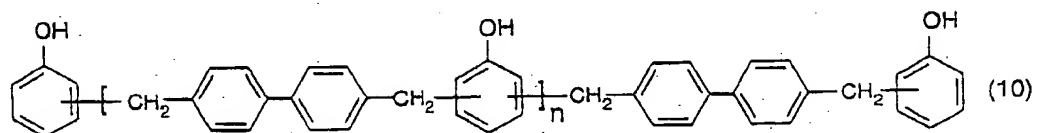
The composition is composed of the inorganic filler (C) and resin components other than the inorganic filler (C) that are comprising the epoxy resin (A), the phenolic resin (B) and the curing accelerator (D), but the composition comprises no flame retardant material nor flame retardant auxiliary.

The composition is an epoxy resin composition for a semiconductor encapsulation which cure into a product exhibiting excellent flame retardancy without any flame retardant material nor flame retardant auxiliary.

The composition contains the inorganic filler (C)

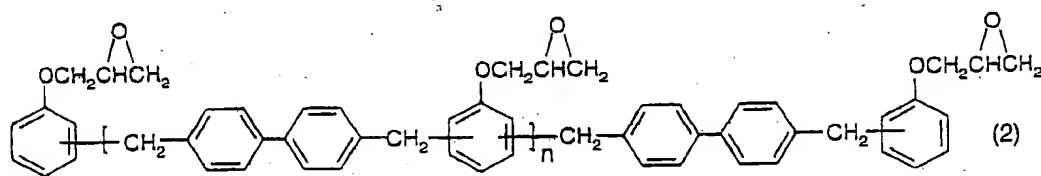
in the equal amount to a content of W (wt%) for the inorganic filler (C) in a cured article being obtainable by curing the composition, wherein the W (wt%) is selected in range of $60 < W \leq 95$.

The phenolic resin (B) is one or a mixture of two or more phenolic resins containing a biphenyl derivative having no hydroxyl group in the molecule represented by formula(10):



wherein $n = 0$ to 10 ,

the epoxy resin (A) is a mixture of a phenolbiphenylaralkyl epoxy resin containing a biphenyl derivative having no epoxy group in the molecule represented by formula (2):



wherein $n = 0$ to 10 ,

the inorganic filler (C) is one or a mixture of two or more fillers selected from the group consisting of fused silica, crystalline silica, or silicon nitride.

A ratio (Ol-1/Ep) of a phenolic hydroxyl group

number (OH) of the total phenolic resin to an epoxy group number (Ep) of the total epoxy resin is $1.0 \leq (\text{OH}/\text{Ep}) \leq 2.5$.

The moiety of the biphenyl derivative having no hydroxyl group is included in a crosslinked structure of the cured article.

A flexural modulus E (kgf/mm^2) at $240 \pm 20^\circ\text{C}$ of the cured article is a value satisfying $0.30W - 13 \leq E \leq 3.7W - 184$ in the case of $60 < W \leq 95$, and the cured article forms a foamed layer during thermal decomposition or at ignition to exert flame retardancy.

In other words, Examples 13-17 of Table 5 may be regarded as examples of such lower-limit case where the ratio of the tetraphenylolthane epoxy resin consisting essentially of an epoxy resin represented by formula (3) to the phenolbiphenylaralkyl epoxy resin epoxy resin of formula (2) is chosen to be 0/5.

Examples 5-8 show such a flame retardant epoxy resin composition comprising an epoxy resin (A), a phenolic resin (B), an inorganic filler (C) and a curing accelerator (D).

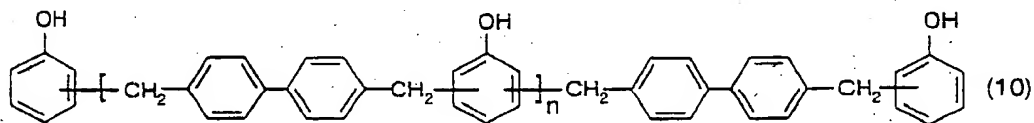
The composition is composed of the inorganic filler (C) and resin components other than the inorganic filler (C) that are comprising the epoxy resin (A), the phenolic resin (B) and the curing accelerator (D), but the composition comprises no flame retardant material nor flame retardant

auxiliary.

The composition is an epoxy resin composition for a semiconductor encapsulation which cure into a product exhibiting excellent flame retardancy without any flame retardant material nor flame retardant auxiliary.

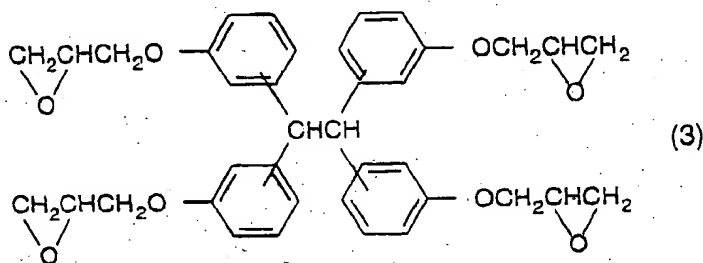
The composition contains the inorganic filler (C) in the equal amount to a content of W (wt%) for the inorganic filler (C) in a cured article being obtainable by curing the composition, wherein the W (wt%) is selected in range of $60 < W \leq 95$.

The phenolic resin (B) is one or a mixture of two or more phenolic resins containing biphenyl derivative having no hydroxyl group in the molecule represented by formula (10):



wherein $n = 0$ to 10,

the epoxy resin (A) is a tetraphenylethane epoxy resin consisting essentially of an epoxy resin represented by formula (3):



The inorganic filler (C) is one or a mixture of two or more fillers selected from the group consisting of fused silica, crystalline silica, or silicon nitride.

A ratio (OH/Ep) of a phenolic hydroxyl group number (OH) of the total phenolic resin to an epoxy group number (Ep) of the total epoxy resin is $1.0 \leq (\text{OH/Ep}) \leq 2.5$.

The moiety of the biphenyl derivative having no hydroxyl group is included in a crosslinked structure of the cured article.

A flexural modulus E (kgf/mm²) at $240 \pm 20^\circ\text{C}$ of the cured article is a value satisfying $0.30W - 13 \leq E \leq 3.7W - 184$ in the case of $60 < W \leq 95$, and the cured article forms a foamed layer during thermal decomposition or at ignition to exert flame retardancy.

In other words, Examples 5-8 of Table 5 may be regarded as examples of such upper-limit case where the ratio of the tetraphenylolthane epoxy resin consisting essentially of an epoxy resin represented by formula (3) to the phenolbiphenylalkyl epoxy resin of formula (2) is chosen to be 5/0.

Based on the above, examples 18-20 of Table 5 may thus be regarded as examples of such middle case where the ratio of the tetraphenylolthane epoxy resin consisting essentially of an epoxy resin represented by formula (3) to

the phenolbiphenylaralykl epoxy resin epoxy resin of formula (2) is chosen to be 1/5.

For instance, the epoxy resin composition of Example 18 is equivalent to a well-mixed mixture of the epoxy resin composition of Example 6 and the epoxy resin composition of Example 14 at mixing ratio in weight (Example 6: Example 14) of 1:5.

Thus, as for the flexural modulus E at 240 °C of the cured article from the epoxy resin composition, the E for Example 18 being 42.3 kgf/mm² falls into the range between 28.2 kgf/mm² for Example 14 and 67.9 kgf/mm² for Example 6. As for Q₁ and Q₂ values of the cured article from the epoxy resin composition, the Q₁ for Example 18 being 9 wt% falls into the range between 12 wt% for Example 14 and 8 wt% for Example 6, and the Q₂ for Example 18 being 42 wt% falls into the range between 39 wt% for Example 14 and 44 wt% for Example 6, respectively. Accordingly, as for ΣF of the cured article from the epoxy resin composition, the ΣF for Example 18 being 15 sec falls into the range between 11 sec for Example 14 and 28 sec for Example 6.

These experimental evidences provide such a reasonable estimation that the E, Q₁ & Q₂, and ΣF for every well-mixed mixture of the epoxy resin composition of Example 6 and the epoxy resin composition of Example 14 at mixing ratio in weight (Example 6: Example 14) of 0:5 to 5:0 will

always fall into the range between those for Example 6 and for Example 14, i.e. the upper-limit and the lower-limit.

Quite similar discussion can be made on the basis of experimental data for the epoxy resin composition of Example 19 in combination with those for Example 8 and Example 16, i.e. the upper-limit and the lower-limit.

At least, there is good evidence indicating that the E, Q_1 & Q_2 , and ΣF for every well-mixed mixture of the epoxy resin composition within the range of 0/5 to 5/0 for the ratio of the tetraphenylolthane epoxy resin consisting essentially of an epoxy resin represented by formula (3) to the phenolbiphenylaralkyl epoxy resin epoxy resin of formula (2) will always be within the range between those for the upper-limit case (5:0) and the lower-limit case (0:5).

In particular, as for the E value, Figure 1 clearly shows such evidence that the middle cases such as Examples 18-20 are indeed positioned between the lower-limit cases (Examples 13-17) and the upper-limit cases (Examples 5-8).

In this view, the specification provides good supporting evidence proving that all the range of 0/5 to 5/0 for the ratio of the tetraphenylolthane epoxy resin consisting essentially of an epoxy resin represented by formula (3) to the phenolbiphenylaralkyl epoxy resin epoxy resin of formula (2) can be chosen to obtain an epoxy resin

composition for a semiconductor encapsulation which cure into a product exhibiting excellent flame retardancy without any flame retardant material nor flame retardant auxiliary.

Accordingly, the specification provides good supporting evidence proving that all the range of $1/5$ to $5/0$ for the ratio of the tetraphenylolthane epoxy resin consisting essentially of an epoxy resin represented by formula (3) to the phenolbiphenylaralkyl epoxy resin epoxy resin of formula (2) can be chosen to obtain an epoxy resin composition for a semiconductor encapsulation which cure into a product exhibiting excellent flame retardancy without any flame retardant material nor flame retardant auxiliary.

In conclusion, a quick comparison of the middle cases such as Examples 18-20 with the lower-limit cases (Examples 13-17) and the upper-limit cases (Examples 5-8) can reasonably convey the technical feature of Claim 34 in question "the ratio of the tetraphenylolthane epoxy resin consisting essentially of an epoxy resin represented by formula (3) to the phenolbiphenylaralkyl epoxy resin epoxy resin of formula (2) is suitably selected within the range of $1/5$ to $5/0$ (i.e. no less than $1/5$)" to one skilled in the relevant art.

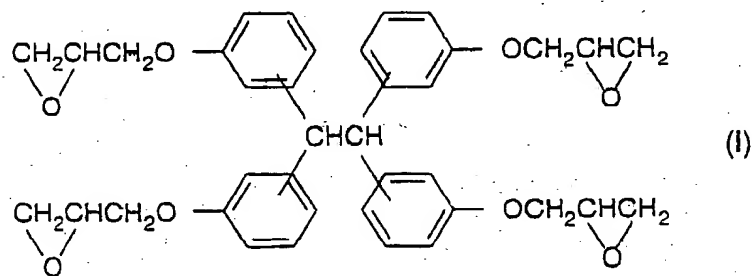
Arguments on the Merits

With respect to the rejection under 35 U.S.C. 103(a) against claims 34-37, 45, 46:

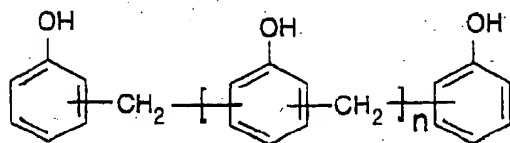
As for cited references AKATSUKA et al.
 (hereinafter "AKATSUKA") JP 9-268219, JP 57-3881 &
 JP 58-150581;

JP 57-3881 & JP 58-150581 teach a process for
 production of the "tetraphenylolthane epoxy resin" of
 formula (3) and typical advantage such that
 "tetraphenylolthane epoxy resin" is suitably employed as a
 raw material for epoxy resin composition that will give a
 cured product having improved thermal properties such as heat
 distortion temperature and equivalent mechanical properties
 to that of cured product from epoxy resin composition
 containing conventional bifunctional epoxy resin.

In particular, JP 57-3881 shows only an example of
 epoxy resin composition comprising 1,1,2,2-tetrakis(4-
 glycidyloxyphenyl)ethane (I):

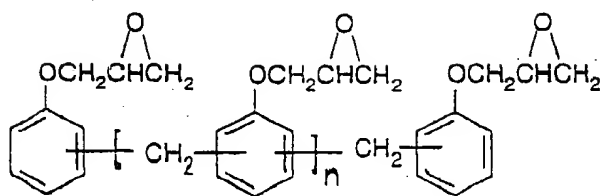


and phenol novolac resin:

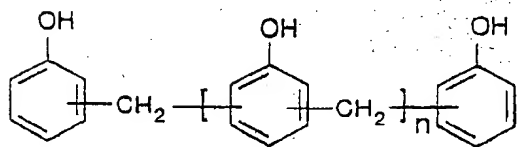


which epoxy resin
 composition gives a cured product having heat distortion
 temperature of 203 °C, in comparison with epoxy resin

composition comprising Epikote 154 (i.e. phenol novolac epoxy resin):



and phenol novolac resin:



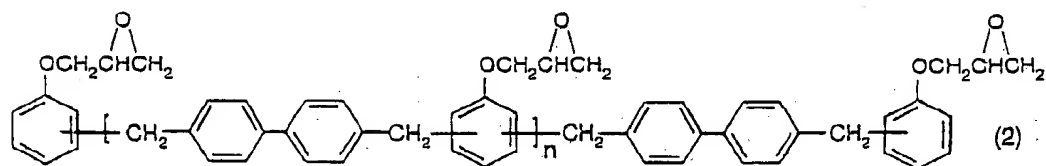
, which epoxy resin composition gives a cured product having heat distortion temperature of 136 °C. This example indicates that use of "tetraphenylolthane epoxy resin" is more suitable than use of phenol novolac epoxy resin such as Epikote 154 for obtaining a cured product having higher heat distortion temperature.

However, JP 57-3881 & JP 58-150581 teach nothing about any effect in relation with good water resistance (i.e. low water absorption) and toughness of cured product from epoxy resin composition containing such a "tetraphenylolthane epoxy resin".

Further, JP 57-3881 & JP 58-150581 teach nothing about any effect in relation with flame retardance of a cured product using an epoxy resin composition containing such a "tetraphenylolthane epoxy resin".

AKATSUKA teaches an epoxy resin composition comprising:

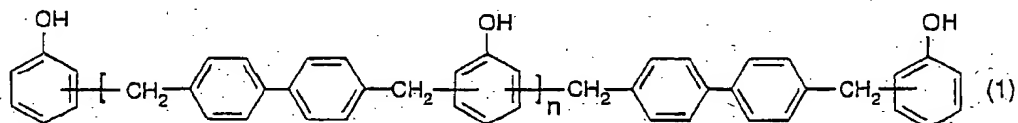
an epoxy resin (phenol-biphenyl aralkyl epoxy resin) represented by formula (2):



wherein $n = 0$ to 10, with the proviso that the percentage of the compound of $n=0$ is 70% or lower in the peak area ratio detected by GPC analysis,

a Novolak type phenolic resin represented by formula (1):

(1):



wherein $n = 0$ to 10, with the proviso that the percentage of the compound of $n=0$ is 70% or lower in the peak area ratio detected by GPC analysis, as a curing agent for said Epoxy resin, and

an inorganic filler in the content of 0 to 90 wt% in the total weight of the epoxy resin composition.

Further, AKATSUKA suggests such preferable embodiment where the ratio (OH/Ep) is chosen in the range of

0.7 to 1.2. AKATSUKA teaches just such advantage that the cured product from said epoxy resin composition will have good heat resistance, water resistance, toughness and mechanical strength.

In addition, AKATSUKA gives some suggestion about such general possibility that the phenol-biphenyl aralkyl epoxy resin of formula (2) may be used therefor in combination with another epoxy resin including novolak type epoxy resin, bisphenol-A type epoxy resin, bisphenol-F type epoxy resin and biphenyl type epoxy resin. The specifically exemplified epoxy resins, such as novolak type epoxy resin, bisphenol-A type epoxy resin, bisphenol-F type epoxy resin and biphenyl type epoxy resin, are essentially of bifunctional epoxy resin type, which has substantially only two epoxy groups in the whole molecule.

At least, AKATSUKA gives no suggestion that the incorporation of other polyfunctional epoxy resins having three or more epoxy groups in the whole molecule as taught by JP 57-3881 and JP 58-150581 is suitable.

In paragraph 33-34 of AKATSUKA, there is clearly described, "If other epoxy resin is used in combination therewith, the ratio of the epoxy resin of the present invention is preferably 30 wt% or more, particularly 40 wt% or more in the total of epoxy resins used therein."

AKATSUKA may suggest that the phenol-biphenyl

aralkyl epoxy resin of formula (2) may be used in combination with other bifunctional epoxy resin such as a novolak type epoxy resin, and in such a case, the suitable ratio of the phenol-biphenyl aralkyl epoxy resin of formula (2) is at least 30 wt% or more in the total of the epoxy resin of formula (2) and other bifunctional epoxy resin.

Further, AKATSUKA clearly indicates that the improved thermal properties, i.e. the improvement in the heat resistance (typically, higher heat distortion temperature or less decrease in vending strength after high temperature treatment) by using "tetraphenylolthane epoxy resin" of JP 57-3881 & JP 58-150581 is not consistent with the objective of better mechanical strength (toughness) desired by AKATSUKA. Indeed, the mechanical strength (toughness) is measured by Izod impact test, in which test sample is used without any high temperature treatment.

In this view, JP 57-3881 and JP 58-150581 by no means suggest that the improved thermal properties due to use of "tetraphenylolthane epoxy resin" would result also in better mechanical strength (toughness) that is examined by Izod impact test.

Accordingly, AKATSUKA in combination with JP 57-3881 and JP 58-150581 fails to reasonably suggest that a combinational use of "tetraphenylolthane epoxy resin" with the phenol-biphenyl aralkyl epoxy resin of formula (2) would

be suitable to achieve an improvement in mechanical strength (toughness) than that obtained by employing only the phenol-biphenyl aralkyl epoxy resin of formula (2).

Moreover, as disclosed in AKATSUKA, only the use of the phenol-biphenyl aralkyl epoxy resin of formula (2) provides sufficiently excellent heat resistance, and thus there is no motivation to further improve heat resistance by using "tetraphenylolthane epoxy resin" in combination with the phenol-biphenyl aralkyl epoxy resin of formula (2).

In addition, AKATSUKA teaches nothing about whether or not the cured product from the aforementioned epoxy resin composition would exhibit good flame retardance without any help of flame retardant material or flame retardant auxiliary.

As for the objectives of AKATSUKA, the main objective is clearly directed to an epoxy resin composition which results in a cured product being excellent in water resisting property and mechanical strength (toughness).

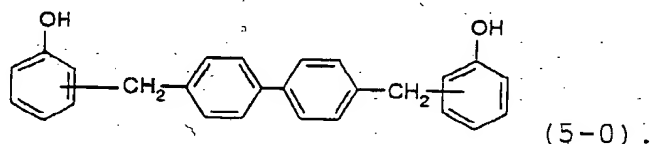
Additionally, paragraph 0003 of AKATSUKA contains such description "although thermal resistance becomes high in the cured product obtained when polyfunctional epoxy resins, such as a cresol novolak epoxy resin, are mixed, said cured product has such fault that toughness falls down and water absorption rise up".

This description appears to indicate that use of

polyfunctional epoxy resin may be unfit for the main aim of AKATSUKA to improve water resistance and toughness. At least, there is no suggestion that combinational use of polyfunctional epoxy resin having three or more epoxy groups in the whole molecule such as "tetraphenylolthane epoxy resin" of JP 57-3881 or JP 58-150581 would be fit to retain the improved water resistance and toughness resulting from the use of the phenol-biphenyl aralkyl epoxy resin of formula (2).

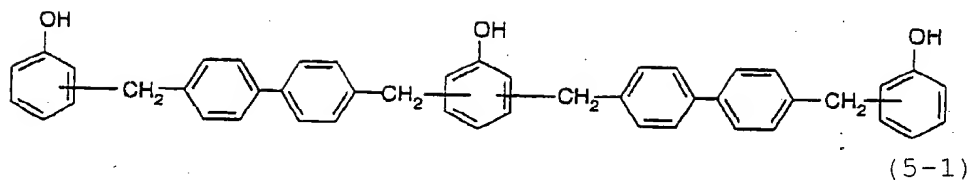
By way of example, the novolak type resin (A) of Example 1 disclosed in AKATSUKA appears to be a mixture of bifunctional phenolic resin and trifunctional phenolic resin, as explained below.

The novolak type resin (A) of Example 1 contains 23% of the compound with $n=0$ as presented by following formula (5-0):



The molecular weight of the compound of formula (5-0) is about 366, and the corresponding hydroxyl equivalent being 183 g/eq.

The compound with $n=1$ as presented by following formula (5-1):



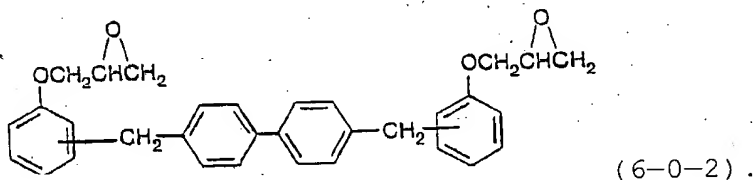
has a theoretical molecular weight of 646, and the corresponding epoxy equivalent being about 215 g/eq.

The observed hydroxyl equivalent of 203 g/eq. for the novolak type resin (A) is equivalent to average for a mixture of 23% of the compound of formula (5-0) and 77% of the compound of formula (5-1), and thus the novolak type resin (A) appears to be a mixture of 23% of the compound of formula (5-0) and 77% of the compound of formula (5-1).

The epoxy resin (B) of Example 2 disclosed in AKATSUKA is prepared by using the novolak type resin (A) as starting material.

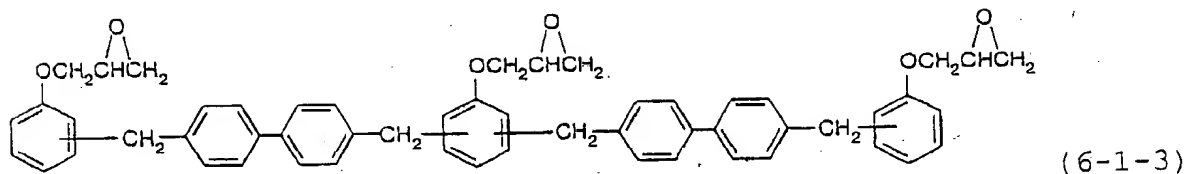
Therefore, the epoxy resin (B) of Example 2 disclosed in AKATSUKA appears to be a mixture of bifunctional epoxy resins and trifunctional epoxy resin, as explained below.

At first, the epoxy resin (B) of Example 2 contains 19% of the compound with $n=0$ as presented by following formula (6-0-2):



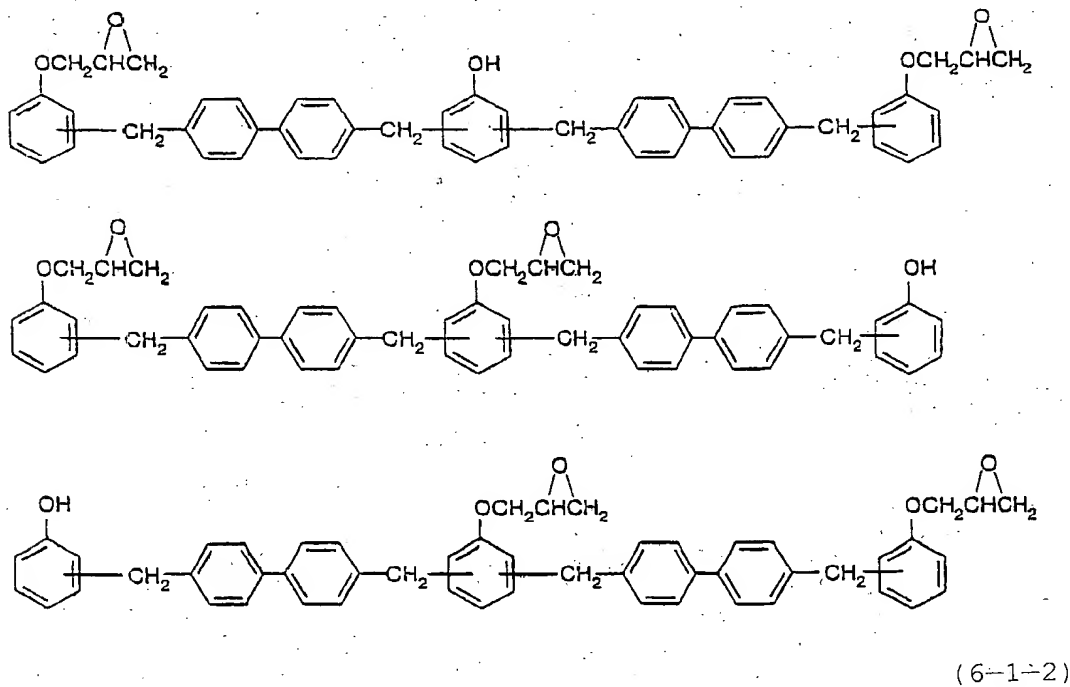
The molecular weight of the compound of formula (6-0-2) is about 478, and the corresponding epoxy equivalent being 239 g/eq.

The compound with n=1 as presented by following formula (6-1-3):



has a theoretical molecular weight of 807, and the corresponding epoxy equivalent being 269 g/eq.

The compound with n=1 as presented by following formula (6-1-2):

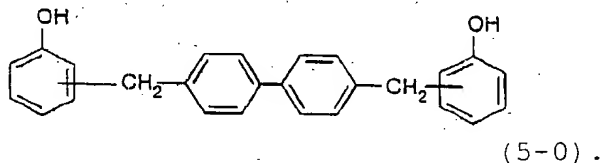


has a theoretical molecular weight of 740, and the corresponding epoxy equivalent being 370 g/eq.

The observed epoxy equivalent of 277 g/eq. for the epoxy resin (B) is equivalent to average for a mixture of 19% of the bifunctional compound of formula (6-0-2), 14% of the bifunctional compound of formula (6-1-2), and 67% of the trifunctional compound of formula (6-1-3), and thus the epoxy resin (B) appears to be a mixture of 19% of the bifunctional compound of formula (6-0-2), 14% of the bifunctional compound of formula (6-1-2), and 67% of the trifunctional compound of formula (6-1-3).

Similarly, the novolak type resin (C) of Example 3 disclosed in AKATSUKA appears to be a mixture of bifunctional phenolic resin and trifunctional phenolic resin, as explained below.

The novolak type resin (C) of Example 3 contains 41% of the compound with $n=0$ as presented by following formula (5-0):



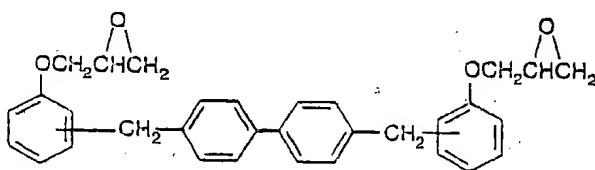
The observed hydroxyl equivalent of 196 g/eq. for the novolak type resin (C) is equivalent to average for a mixture of 41% of the compound of formula (5-0) and 59% of

the compound of formula (5-1), and thus the novolak type resin (C) appears to be a mixture of 41% of the bifunctional compound of formula (5-0) and 59% of the trifunctional compound of formula (5-1).

The epoxy resin (D) of Example 4 disclosed in AKATSUKA is prepared by using the novolak type resin (C) as starting material.

Therefore, the epoxy resin (D) of Example 4 disclosed in AKATSUKA appears to be a mixture of bifunctional epoxy resins and polyfunctional epoxy resin, as explained below.

First, the epoxy resin (D) of Example 2 contains 35% of the compound with $n=0$ as presented by following formula (6-0-2):



(6-0-2).

The observed epoxy equivalent of 271 g/eq. for the epoxy resin (D) is equivalent to average for a mixture of 35% of the bifunctional compound of formula (6-0-2), 13% of the bifunctional compound of formula (6-1-2), and 52% of the trifunctional compound of formula (6-1-3), and thus the epoxy resin (B) appears to be a mixture of 35% of the bifunctional

compound of formula (6-0-2), 13% of the bifunctional compound of formula (6-1-2), and 52% of the trifunctional compound of formula (6-1-3).

Taking these typical examples in consideration, AKATSUKA seems to suggest only that use of a mixture of bifunctional epoxy resin and trifunctional epoxy resin may be suitable for the main aim of AKATSUKA to improve water resistance and toughness. However, AKATSUKA gives no suggestion that use of a mixture of bifunctional epoxy resin and trifunctional epoxy resin in combination with considerable amount of tetrafunctional epoxy resin such as "tetraphenyleneoxy epoxy resin" would be also useful to improve water resistance and toughness.

On the other hand, there is no reasonable basis to expect that the cured product obtained with use of "tetraphenyleneoxy epoxy resin" of formula (3) would show as good water resistance and toughness as the cured product obtained with use of phenol-biphenyl aralkyl epoxy resin of formula (2). The description of paragraph 0003 of AKATSUKA may give rather a suggestion such that water absorption would undesirably increase and toughness would undesirably decrease in case of using the "tetraphenyleneoxy epoxy resin" of Ref. 11 or Ref. 12 as well as use of polyfunctional epoxy resins such as a cresol novolak epoxy resin.

In this view, a person skilled in the art may think

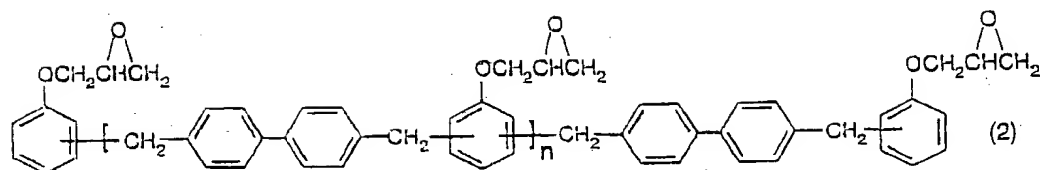
at least that such combinational use of "tetraphenylolthane epoxy resin" of JP 57-3881 or JP 58-150581 with the phenol-biphenyl aralkyl epoxy resin of formula (2) is not consistent with the purpose of AKATSUKA for obtaining the cured product being superior in water resistance and toughness.

At least, JP 57-3881 & JP 58-150581 fail to provide any reasonable suggestion that use of "tetraphenylolthane epoxy resin" of formula (I) will give a cured product being excellent in water resistance and toughness.

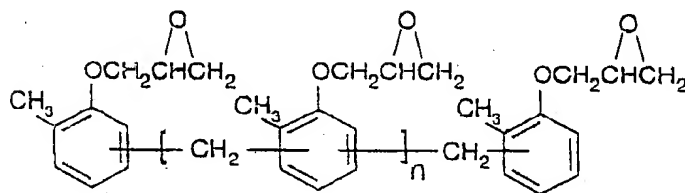
Thus, there is no reasonable predication that the inclusion of "tetraphenylolthane epoxy resin" in place of "cresol novolak epoxy resin" would be consistent with the objectives of AKATSUKA to provide excellent water resistance and toughness for a cured product thereof.

In conclusion, there is no motivation for a combinational use of polyfunctional epoxy resins such as the "tetraphenylolthane epoxy resin" of formula (I) with the epoxy resin (phenol-biphenyl aralkyl epoxy resin) represented by formula (2), wherein the ratio of the tetraphenylolthane epoxy resin to phenolbiphenylaralkyl epoxy resin of formula (2) is no less than 1/5 in order to provide excellent water resistance and toughness for a cured product thereof.

In addition, the epoxy resin (phenol-biphenyl aralkyl epoxy resin) represented by formula (2):



wherein $n = 0$ to 10, as well as the "cresol novolak epoxy resin":



are included in group of polyfunctional epoxy resins. Therefore, use of epoxy resin (phenol-biphenyl aralkyl epoxy resin) represented by formula (2) may provide enough improvement with respect to the heat distortion temperature by itself. In such a case, there would be no need to further use the "tetraphenylmethane epoxy resin" of formula (I) in combination with the epoxy resin (phenol-biphenyl aralkyl epoxy resin) represented by formula (2) in order to obtain a cured product with high heat distortion temperature.

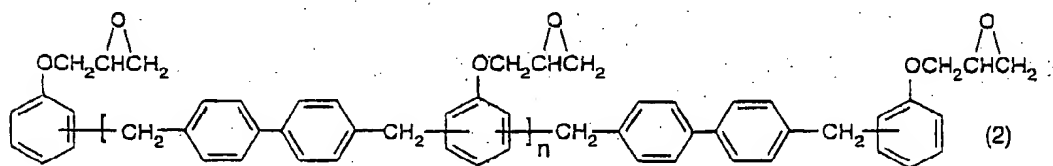
Moreover, there is no evidence indicating that a cured product having good heat resistance will always exhibit good water resistance and toughness. There is no evidence indicating that a cured product having good heat resistance, water resistance and toughness will always exhibit good flame retardance without any help of flame retardant material or

flame retardant auxiliary.

Indeed, referring to SHIMIZU et al. U.S. Patent 5,854,316, which was cited in the Office Action dated January 22, 2003, a cured product from comparative Example (6) listed in TABLE 2 has good heat resistance, water resistance and toughness, but the cured product from Comparative Example (6) exhibits poor flame retardance of V-2 grade.

With reference to OSADA et al. U.S. Patent 6,160,078, which was cited in the Office Action dated September 14, 2004, a cured product from epoxy resin composition of Example 1 has good heat resistance, and the cured product also exhibits good flame retardance of V-0 grade. A cured product from epoxy resin composition of Comparative Example 2 has good heat resistance, but the cured product exhibits poor flame retardance "burned".

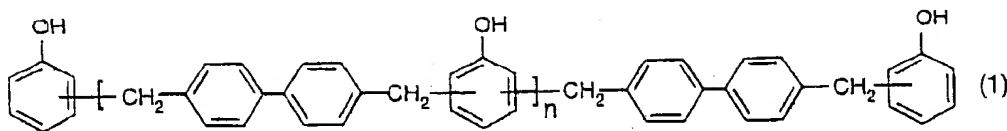
As for cured product having improved flame retardance without any help of flame retardant material or flame retardant auxiliary, AKATSUKA fails to provide any evidence suggesting that the cured product from an epoxy resin composition comprising an epoxy resin (phenol-biphenyl aralkyl epoxy resin) represented by formula (2):



wherein $n = 0$ to 10,

a Novolak type phenolic resin represented by

formula (1) :



wherein n = 0 to 10, as a curing agent for said

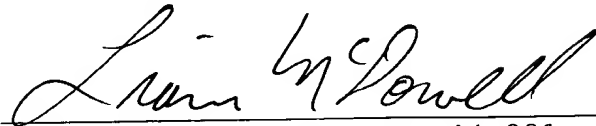
In conclusion, AKATSUKA in view of JP 57-3881 & JP

The Commissioner is hereby authorized in this,

any overpayment to Deposit Account No. 25-0120 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17.

Respectfully submitted,

YOUNG & THOMPSON

A handwritten signature in cursive script, reading "Liam McDowell", written in dark ink over a horizontal line.

Liam McDowell, Reg. No. 44,231
745 South 23rd Street
Arlington, VA 22202
Telephone (703) 521-2297
Telefax (703) 685-0573
(703) 979-4709

LM/fb